meaning. The relation of soils to underlying rocks, and of crops to soils make very instructive points. Considerable mineral wealth is found in coal, gypsum, and lithographic limestone in large slabs. These of sufficient size to be valuable are not obtainable elsewhere in the United States.

The notes and diagrams on climate are good but disappointing because they do not indicate the significance of the condition of the meteorologic elements from a geologic point of view. There is little utility in giving space in a geologic report to climatic notes unless some use is made of them. The climate must have characteristic influence on erosion, soil formation, soil transportation, etc. The position of volcanic ash to the eastward of the volcanoes, now extinct, just west of the Black Hills shows similarity of winds in the White River time to those of the present time.

Why cannot the U. S. G. S. reports, in discussing such a region as this, have a section on geography? It should embrace most if not all of the section here devoted to topography, but should go farther with the question, incorporating some that is said under soils, climate, water resources, etc., and then discuss the influence of relief, soil and water on products, transportation, distribution of plants and animals, man, and his various occupations.

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The High Plains and Their Utilization. By WILLARD D. JOHNSON. [Extract from the Twenty-first Annual Report of the U. S. Geol. Surv., 1899–1900, Pt. IV, Hydrography; pp. 601–768; Plates CXIII–CLVI.]

THE High Plains, as defined in the first chapter, correspond approximately to the Central Plains. They form a belt extending from central Texas northward across Oklahoma and western Kansas into Nebraska, but are more characteristic in Texas because less eroded. By topographic difference they constitute a topographic unit of the great geographic unit—the Great Plains. The High Plains practically have no drainage, hence their surface is in general a dead level known locally as the "Flats."

Chapter II discusses the origin of these plains. They are the

remnants of an old débris apron built in the latter half of Tertiary time, and preserved because of lack of sufficient precipitation to produce run-off. The author takes the ground that this apron of waste was deposited and arranged by streams, but shows that the streams were not of the ordinary type. A careful analysis of arid region stream work leads to the conclusion that "there is no such thing as sheet flow" in the sense of a uniform flood of water and waste, but that the more or less perfect sheet is "one of intimately lacing threads of current."

The deposits of which the plains are composed are the result of this stream work and not of still water work. As proof of the proposition, the author finds the following facts:

(1) Wide distribution, at all depths of gravels, which decrease in size from the mountains. (2) The size of these coarse materials is often that of cobbles. (3) Gravel courses run east and west and are cross-bedded—marking the channel courses of eastward flowing streams. (4) Sand bed salso occur in courses elongated east and west in the "clays." (5) Interlaced stream beds occur as shown where erosion has disclosed them. (6) Even most clay beds are thin and elongated east and west.

Mr. Johnson finds the "mortar-beds" cutting across the local bedding of sands and gravels, and he considers the beds to have been formed by the cementation of the coarse materials at the level of the ground water by salts carried down in the sinking surface water. It appears that his explanation of the distribution of water in these gravels is similar to that of water distribution in the morainic materials of Illinois and Indiana, as worked out by Leverett and others, and stated by Leverett in the Eighteenth Annual Report of the U. S. Geol. Surv. Pt. IV.

Chapter III is a discussion of the "deficiencies of climate." The climate of the High Plains is described as subhumid. It varies from humid to arid through a period of years. The author very properly states that the amount of precipitation is not the only factor in determining the climate, or even the arability of a region. The Dakota wheat fields actually have less rainfall than the Staked Plains of Texas, but the rainfall is more effective in Dakota. In Texas (1) rainfall is more spasmodic; (2) temperature is higher, increasing evaporation and decreasing relative humidity; (3) there are more hours of sunshine, and (4) greater wind movement. In the summary he reaches

two conclusions which are thoroughly borne out by the facts and discussion. (*a*) A truer index of climate than rainfall is relative humidity. (*b*) Observations covering a quarter of a century indicate that no change in climate, save that of short-period oscillations, takes place. While the High Plains area is a climatic unit, it shows evidence of agreement in the series of climatic changes through Pleistocene, with the Great Basin lake fluctuations, and with the advance and retreat of the Rocky Mountain glaciers.

The fourth chapter gives a graphic picture of the boom of 1888–1893, with the subsequent disasters, and some suggestions as to what may be grown on the High Plains.

Chapter V proves the impossibility of general irrigation within the High Plains. The facts are as follows: (1) The rainfall and streams are wholly inadequate; (2) the mountain streams from the west are so loaded with waste that ponds to retain their waters would be exceedingly short-lived; (3) all mountain streams must pass through a broad, arid, fertile strip amply sufficient to utilize all their waters; (4) artesian water in very small quantity is found in the valleys, but the entire supply is altogether too small for general irrigation. This source, however, is sufficient to furnish water for a garden and ranch headquarters at occasional intervals.

In the closing pages there is a discussion of the origin of peculiar sink holes, and a theoretic explanation of the movements of underground waters. This last brings together considerable valuable material which formerly has been scattered and little known, but it presents scarcely anything new.

The author thus states his purpose at the outset, and he accomplishes his object: "To show that the High Plains, except in insignificant degree, are non-irrigable, either from streams, flowing or stored, or from underground sources, and that, therefore, for general agriculture, they are irreclaimable; but that, on the other hand, water from underground is obtainable in sufficient amount for reclamation of the entire area to other uses; that such reclamation has in fact already begun, and is in progress of gradual, but sure development; and that it will be universally profitable."

This paper will be of great service to those in the arid and subarid regions, and to those who may contemplate immigration thither, because it gives authentic information concerning fertility and water-supply there. But the value of the paper is not alone in its descriptive

work. To science the able discussions of causes and effects, of climatic relations to geology, geography, and agriculture, of water-supply, etc., are the most attractive features. The pages devoted to underground water resources are specially strong. The only regret is that the paper is not finished.

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The Bauxite Deposits of Arkansas. By CHARLES WILLARD HAYES, U. S. Geological Survey, Twenty-first Annual Report, Part III, pp. 435–472. Maps and plates.

COMMERCIAL deposits of bauxite have been known in Arkansas since 1890, when they were first discovered by the State Geological Survey. The present report by Dr. Hayes represents, however, the first detailed systematic study of these deposits, and its appearance when developments are just beginning in the area, makes it a very timely one.

Preliminary to the description of the Arkansas deposits proper, the report opens with a brief summary of the "distribution of bauxite deposits in the United States." The Arkansas deposits are limited to a small area twenty miles long and five or six miles wide, lying south and southwest of Little Rock, in the adjacent parts of Pulaski and Saline counties. The most important deposits of the state are grouped into two districts, with less important isolated ones between. The general geologic and physiographic relations of the region are recounted in some detail, derived largely, as the author says, from the state survey reports. Three distinct groups of rocks are made out, namely, the Paleozoic sediments in the northwest, the Tertiary and recent sediments on the southeast, and areas of intrusive igneous rocks in the two bauxite districts. The Paleozoic rocks are similarly folded and closely resemble those of the Alabama-Georgia-Tennessee area of the southern Appalachians. The region was probably several times reduced to a nearly featureless plain, and sometime after the folding, probably, during Cretaceous, the igneous rocks were, according to Williams, intruded. Beginning with the Cretaceous, the region was several times invaded by the sea and Tertiary sediments still form a considerable part of the area.

In the detailed description of the deposits, the two districts are